

A NEW SPECIES OF MARINE LEECH (ANNELIDA: HIRUDINEA)
FROM SOUTH CAROLINA, PARASITIC ON THE ATLANTIC
MENHADEN, *BREVOORTIA TYRANNUS*¹

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The current systematics of marine leeches is in a confusing state in spite of recent attempts to review the group (Knight-Jones, 1961; Soós, 1965). Unfortunately, the internal anatomy of many of the type species has been so inadequately described that in most cases the exact limitations of the genera are only vaguely known. Recent workers have pointed out also that an initial dichotomy based on environment (*i.e.*, freshwater or marine) is completely unsatisfactory (Hoffman, 1964). In contrast to the freshwater piscicolid leeches of the United States and Canada which have been thoroughly investigated by Meyer (1940, 1946a, 1946b), very little is known of American marine piscicolids. Although at least eight marine fish leeches have been reported along the eastern American coasts, a comprehensive morphological study is lacking and new species and even genera are not uncommonly encountered. Since 1963, we have sporadically encountered a previously undescribed marine piscicolid of the *Calliobdella-Cystobranchus-Piscicola* complex in the vicinity of Charleston, South Carolina. The mid-body segments of the young (3 mm) of the new species are made up of 3(6) annuli which, upon maturation, are further subdivided into the typical 7(14)-annulate condition of the adults. A similar subdivision of the mid-body annuli upon maturation was found in the marine leech *Occanobdella blennii* by Sawyer (1970), who discussed the systematic significance of annulation in the piscicolids. In this paper we hope to contribute to the stabilization of the systematics of marine piscicolids by keeping with the modern approach of giving systematic emphasis to the more conservative internal structures, especially the reproductive systems, and minimizing the importance of such external characters as the degree of annulation, the emphasis on which in the past has led to a confusing proliferation of genera. A detailed morphological examination has shown the reproductive systems and other internal structures of the new species resemble so remarkably those of the genus *Calliobdella*, which has only two known species (Soós, 1965) that the new species must be assigned to this genus.

Family Piscicolidae, Johnston, 1865

Genus *Calliobdella* van Beneden and Hesse, 1863

TYPE SPECIES (by original designation): *C. lophii* van Beneden and Hesse, 1863.

REVISED DEFINITION OF GENUS: Body sub-cylindrical, not sharply divided into urosome and trachelosome; smooth without papillae or tubercles; caudal sucker wider

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than the maximum width of the body and about twice the width of the oral sucker; mouth central; 0-2 pairs of eyes; mid-body segments 3(6)- or 7(14)-annulate; six pairs of testes; 11-13 pairs of pulsatile vesicles; coelomic system well developed; posterior crop ceca fused, with fenestrae; esophageal diverticula and conducting tissue present; no external copulatory zone; with a medial, muscular organ associated with the bursa; marine.

Calliobdella carolinensis sp. nov.

Figures 1-3

Total length of sexually mature adults including suckers, about 18 mm (range, including juveniles 2.3-30 mm); first two nuchal annuli constricted; oral and caudal suckers eccentrically attached; mid-body segments 14-annulate; two pairs of cephalic ocelli; no ocelli on caudal sucker; transverse bands of metameric pigmentation on oral sucker and segments VII through XII; 11 pairs of pulsatile vesicles on segments XIII through XXIII; 12 pairs of metameric pigment spots from segments XIII through XXIV; anterior portion of vas deferens convoluted and extending to ganglion IX; a well-developed medial, muscular organ which functions as a seminal receptacle confluent anteriorly with the bursa and posteriorly with the ovisacs. Known hosts: Clupeidae Fish: the Atlantic menhaden *Brevoortia tyrannus* (Latrobe) and the blueback herring *Alosa aestivalis* (Mitchill).

TYPE LOCALITY: Beresford Creek near the Wando River, Berkeley County, about 13 km north-northeast of Charleston, South Carolina (32°53.2'N; 79°52.7'W). Host, *Brevoortia tyrannus* (Latrobe), captured by D. L. Hammond in an otter trawl near mud bottom in about 6 m of water. Bottom water temperature: 10.1° C; salinity: 13.0‰. In all, twelve leeches, ranging in length from 7.5 mm to 30.0 mm, were found on 12 January 1971 on *B. tyrannus* and on the deck of the boat. The holotype and three of the paratypes are deposited in the Grice Marine Biological Laboratory (Reference numbers: Holotype 71-138-1; Paratypes 71-138-2). The other paratypes are deposited in the Charleston Museum (Reference number: 71-67) and in the U. S. National Museum (Reference number: 45601).

HOLOTYPE (Fig. 1, A-F): The elongated body, translucent in the living animal, is barely perceptibly divided into a rounded trachelosome (length, 3.5 mm) and a more flattened urosome (length, 13.0 mm). Total length, inclusive of the suckers, is 18.5 mm; the width of the posterior sucker (2.0 mm) is greater than that of the body at its maximum width (1.6 mm), and twice the width of the oral sucker (1.0 mm). The ratio of the maximum body width to length is 1:11.6. The mouth is centrally located in the deeply cupped, almost hemispherical oral sucker, which is eccentrically attached to the neck immediately above its posterior edge. The first two or three nuchal annuli are so narrowly constricted (0.4 mm) that they can be telescoped slightly into the other annuli of the neck. The neck annuli gradually widen to become continuous with the externally unmarked clitellar (X through XII) region. From segment XIII the slight but perceptible widening of the body marks the beginning of the urosome which is slightly flattened dorsoventrally. From segments XIII through XX the sides of the body are almost

parallel. Eleven well-defined pairs of lateral pulsatile vesicles occur immediately posterior to the ganglia in segments XIII-XXIII, inclusive. The vesicles become progressively smaller as well as positioned relatively more posteriorly in their respective segments. The surface of the body and the suckers is otherwise smooth,

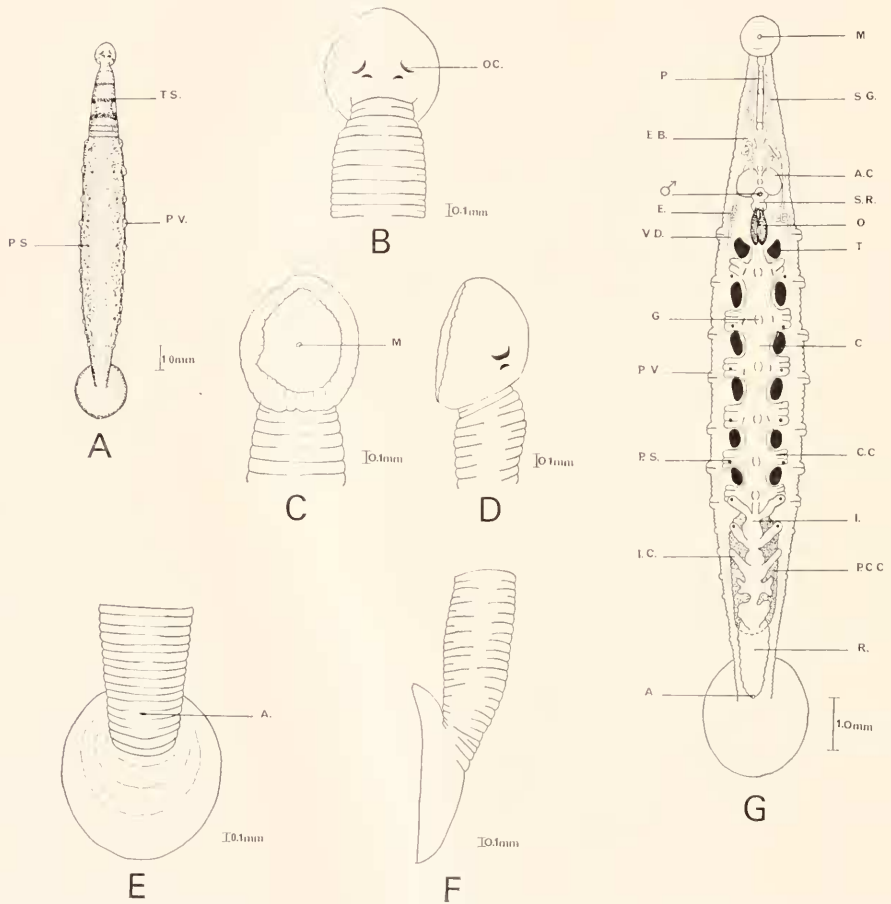


FIGURE 1. *Calliobdella carolinensis* sp. nov.; A-F, holotype; A, dorsal view of entire individual; B-D, close-up of oral sucker; B, dorsal view; C, ventral view; D, lateral view; E-F, close-up of caudal sucker; E, dorsal view; F, lateral view; G, reconstruction of the digestive and reproductive systems; a, anus; a.c, atrial cornus; c, crop; c.c, crop ceecum; e, epididymis; e.b, ejaculatory bulb; g, ganglion; i, intestine; i.c, intestinal caecum; m, mouth; o, ovisacs; oc, ocellus; p, proboscis; p.c.c, posterior crop ceecum; p.s, pigment spot; p.v, pulsatile vesicle; r, rectum; s.g, salivary gland; s.r, seminal receptacle; t, testis; t.s, transverse stripe; v.d, vas deferens.

no papillae, tubercles or gills being present. Upon clearing with xylol, some of the internal organs can be detected: the tubular proboscis and large salivary glands extending posteriorly to segment IX, inclusive, coiled sperminiferous tubules almost as far anterior as IX, six pairs of testisacs in segments XIII through

XVIII, metameric crop and intestinal ceca, and numerous clitellar gland cells in the urosome. The mid-body segments appear 7(14)-annulate, but this is somewhat obscured. The annulation is reduced in the clitellar region, X through XII. The male gonopore is slightly elevated ventrally, but the female gonopore could not be found externally. The anus is barely visible about three annuli from the posterior sucker. The caudal sucker is somewhat longer (2.2 mm) than wide (2.0 mm), eccentrically attached to the body about one-third the distance from the anterior rim.

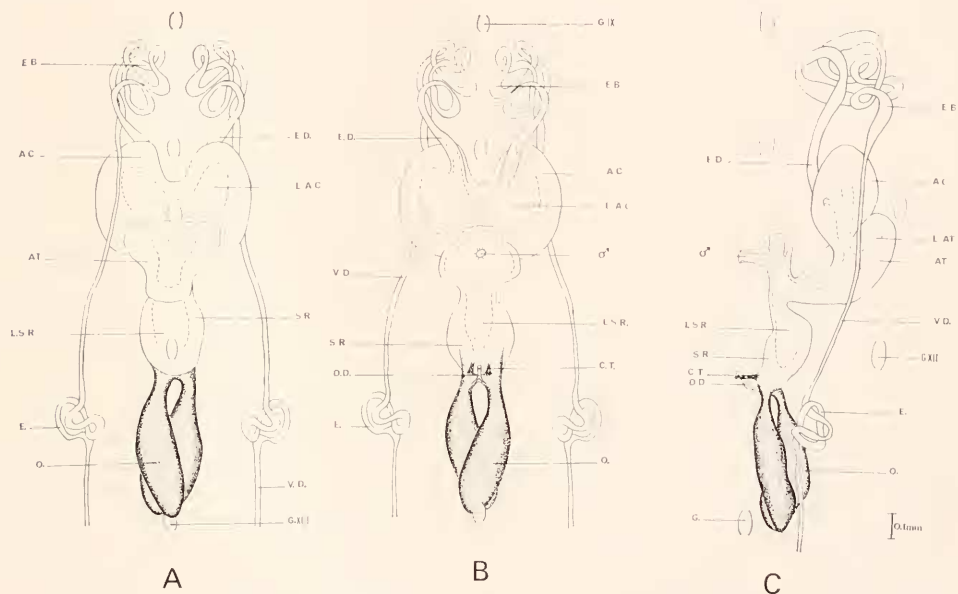


FIGURE 2. *Calliobdella carolinensis*; reconstruction of the reproductive systems. The dotted lines indicate the outlines of the lumina of the atrium, atrial cornua, bursa, and the seminal receptacle; A, dorsal view; B, ventral view; C, lateral view; a.c, atrial cornua; at, atrium; c.t, conducting tissue; e, epididymis; e.b, ejaculatory bulb; e.d, ejaculatory duct; g, ganglion; l.a.c, lumen of atrial cornua; l.a.t, lumen of atrium; l.s.r, lumen of seminal receptacle; o, ovisac (shaded); o.d, oviduct; s.r, seminal receptacle; v.d, vas deferens. (The female gonopore was not discernible externally.)

Two pairs of crescent-shaped ocelli, consisting of web-like concentrations of black pigment, are located on the anterior sucker (Fig. 1, B), a large anterior pair directed anteriorly and slightly laterally, and a small, more medial pair directed slightly posteriorly. No ocelli occur on the caudal sucker. Scattered over most of the suckers and body are two types of large chromatophores: a peripheral, reddish-brown and a deeper, blackish type. Faint indications of metameric pigmentation consist of narrow transverse bands, especially toward the anterior end (Fig. 1, A): one faint band on the oral sucker in the region of the posterior pair of ocelli, four distinct bands on the trachelosome, and three narrow bands in the clitellar region. These bands are not readily distinguishable on the urosome. Along the lateral margins of the urosome are thirteen faint pairs

of triangular-shaped whitish areas devoid of chromatophores. Twelve pairs of pigment spots are barely discernible dorsally from segments XIII through XXIV (possibly a thirteenth in segment XXV), and eight pairs ventrally in segments XIII through XX. They are located near the body wall posterior to the ganglion and anterior to the vesicle.

PARATYPES AND VARIATIONS: More than 500 individuals of *C. carolinensis* have been collected and examined alive from several localities around and in Charleston harbor, ranging in size from 2.3–30 mm. They all possess two pairs of ocelli on the oral sucker, no ocelli on the caudal sucker, and the two types of scattered chromatophores. In addition, most of the living individuals display: twelve pairs of dorsal pigment spots on segments XIII through XXIV, faint indications of metamerism pigmentation, six pairs of testisacs (visible with transmitted light), blood-filled crop ceca and intestinal ceca, a barely detectable division between urosome and trachelosome, 14 (sometimes 12) annuli per mid-body segment (sometimes obscure and hard to interpret), and 11 pairs of pulsating lateral vesicles. The annulation closely resembles that described for *Marsipobdella sacculata* by Moore (1952), except the testisacs do not extend so far posteriorly in the segment. There is a barely detectable metamerism sequence in the furrowing of the annulation with the deepest furrow (probably at $C_{5,6}/C_7$) immediately anterior to the vesicle. Within the intestines of most individuals just in front of the last pair of vesicles is a conspicuous blackish ball, presumably partially decomposed food.

The basic body shape is often grossly distorted during fixation and the faint indications of metamerism pigmentation is often obliterated after being in preservative for some time. If preserved without prior relaxation with weak ethanol the pulsatile vesicles are often obliterated, and even after careful preservation only six or seven vesicles may remain intact. Similarly the twelve pairs of urosomal pigment spots, never very conspicuous in the living animal, may be lost or show up only upon clearing. Only six or seven pairs of spots may remain intact. The caudal sucker can be folded along the longitudinal axis. The tertiary nature of the mid-body annulation is especially affected by poor preservation, so that at times the segments appear to have 6(7) annuli per segment. If preserved without prior relaxation, the male bursa may be everted posteriorly and the proboscis may be everted through the mouth. The smaller, immature individuals (2–10 mm) differed from the adults in being much less pigmented, more translucent, almost cylindrical with less of a division between trachelosome and urosome, and less conspicuous or even internal pulsatile vesicles. Similar differences between young and adult marine piscioloids were noted in *Occanobdella blennii* by Sawyer (1970).

This section is based on the histological examination of four representative individuals, 3, 14.6, 17, and 18 mm in length, all sectioned at 15–20 μ m and stained with Ehrlich's haematoxylin and eosin. The leech nervous system consists of a chain of thirty-four ganglia connected by a double nerve cord. The first six (I–VI) are aggregated to form the brain and the last seven (XXVIII–XXXIV) are aggregated to form the caudal mass. The remaining twenty-one ganglia (VII–XXVII) are segmentally arranged between them.

COELOMIC SYSTEM: The well-developed coelomic system resembles that of *Calliobdella*, *Cystobranchus*, *Piscicola*, and *Trachelobdella* (Type I of Selensky 1915).

The ventral sinus, which surrounds the nerve cord and the ventral blood vessel, is especially prominent in the region of the ganglia where wing-like projections extend dorso-laterally, but is reduced in the testicular region. The dorsal sinus, which surrounds the dorsal blood vessel, is especially prominent in the interganglionic regions. Both the ventral sinus and the dorsal sinus extend most of the length of the body. Small sinuses are also associated with the ovisacs and testisacs. A large sinus surrounds most of the intestine. The paired lateral sinus, which extends from about ganglion XIII to the intestinal region, is more prominent in the interganglionic regions, especially along the anterior portion of its length. It is continuous with the dorso-lateral projections from the ventral sinus as well as with a dorsal transverse sinus, which traces a somewhat tortuous path from the lateral sinus anteriorly and medially to the dorsal sinus.

Within each pulsatile vesicle there is a two-chambered sinus lined with a flattened epithelium and located outside the body wall. From the postero-dorsal portion of the dorsal chamber extends a tubular sinus connective through the body wall. It has not been determined whether this connective is continuous with the lateral sinus. The coelomic system of the immature (3 mm) specimen is somewhat reduced. The pulsatile vesicles especially differ from the adult condition in being quite small and internal.

DIGESTIVE SYSTEM (Fig. 1, G): The proboscis, a tube 125 μ in diameter with a narrow triangular lumen, extends posteriorly to segment IX. The paired salivary glands, up to 140 μ in length, are located between ganglia VII and IX. The esophagus enlarges laterally immediately posterior to the proboscis. A pair of anteriorly directed lateral ceca from the esophagus is confluent with the gut at ganglion XI, but it has not yet been determined whether these correspond with the esophageal diverticulae ("esophageal gland") located at this position in many marine piscicolids (see Sawyer, 1970). The gut lumen narrows somewhat in segment XI and expands laterally into the crop at segment XII. The crop lumen narrows in the testicular regions of segments XIII to XVIII, inclusive, and expands laterally as crop ceca in the intertesticular regions of these segments. Well-developed dorso-ventral muscles occur on either side of the gut between the crop ceca. The intestine and the posterior crop ceca originate just posterior to ganglion XIX. The convoluted intestine has five pairs of anteriorly directed, convoluted ceca. The posterior crop ceca, which extend from segments XIX to XXV), inclusive, are fused except for a fenestra in each segment through which dorso-ventral muscles or strands of connective tissue pass.

REPRODUCTIVE SYSTEM (Fig. 2, A-C; Fig. 3, A-F): The six pairs of testisacs, immediately posterior to the ganglion in each of the segments XIII through XVIII, are connected to a dorso-lateral pair of vasa deferentia. Each vas deferens proceeds anteriorly to the region anterior to ganglion XIII where it enlarges and becomes the severely convoluted, sperm-filled epididymis. Narrowing again, the vas deferens extends anteriorly to ganglion X where the lumen greatly enlarges into the sperm-filled ejaculatory bulb (spermiducal gland of Hoffman, 1964), which is also severely convoluted (Fig. 3, A). The convolutions of the ejaculatory bulb extend as far anteriorly as the posterior part of segment IX. The lumen becomes confluent with the ejaculatory duct which proceeds posteriorly as well as ventro-medially

where it enters the ventro-medial part of the rounded atrial cornu (Fig. 3, E) at ganglion XI. The lumina of the paired atrial cornua proceed ventro-medially to become confluent in the large medial atrium (Fig. 3, C). The lumen of the atrium

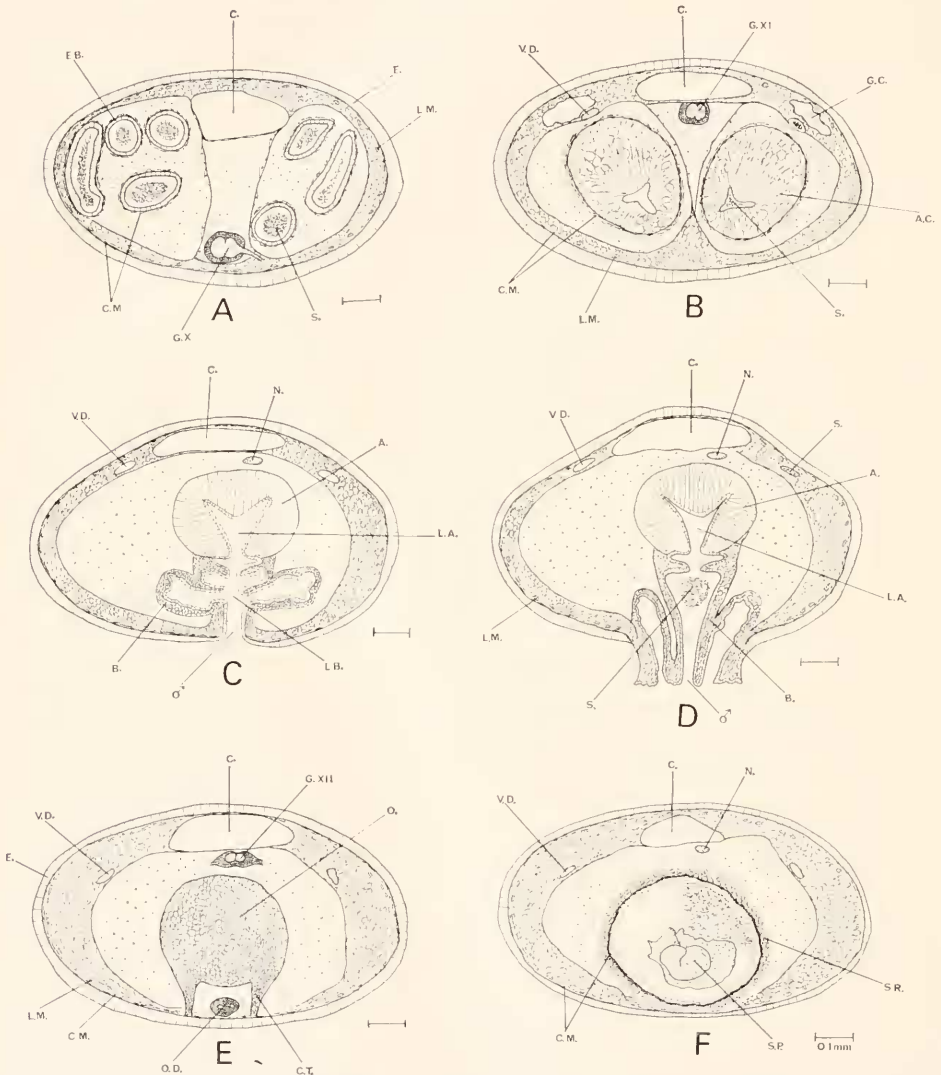


FIGURE 3. *Calliobdella carolinensis*; cross-sections through various regions of the reproductive system; A, ejaculatory bulb, at region of ganglion X; B, atrial cornua, at region of ganglion XI; C, bursa (not everted), immediately posterior to ganglion XI; D, bursa everted to form an intromittent structure (based on a specimen fixed *in coitu*), immediately posterior to ganglion XI; E, ovisacs, at region of ganglion XII; F, seminal receptacle, anterior to ganglion XII; a, atrium; a.c, atrial cornu; b, bursa; c, crop; c.m, circular muscles; c.t, conducting tissue; e, epidermal cells; e.b, ejaculatory bulb; g, ganglion; g.c, gut caecum; l.a, lumen of atrium; l.b, lumen of bursa; l.m, longitudinal muscles; n, nerve cord; o, ovisacs; o.d, oviduct; s, spermatozoa; s.p, spermatophore; s.r, seminal receptacle; v.d, vas deferens.

bends ventrally to become confluent at XI/XII with the lumen of the spacious, sacular bursa (Fig. 3, C), which in turn leads to the male gonopore. The non-glandular bursa is capable of being protruded externally to form a true copulatory organ (Fig. 3, D). We have observed true copulation in this species on numerous occasions.

The anatomy of the reproductive system in *C. carolinensis* is remarkable in having, from XI/XII to immediately posterior to ganglion XII, an unpaired "seminal receptacle" (Fig. 3, F), which probably corresponds with the paired vesiculae seminales of Johansson (1896) and Leigh-Sharp (1914). The anterior portion of the lumen of this structure is lined by a thin layer of secretory cells which are completely encircled by a layer of circular muscles. The extreme posterior portion of the slightly bilobed seminal receptacle is continuous with the cells (possibly vector tissue) of the anterior portion of the female reproductive system (Fig. 2, s. r.). Sections from a specimen fixed *in coitu* revealed a true seminal receptacle containing numerous spermatozoa and a structure which appears to be a spermatophore (Fig. 3, F, s. p.): a bilobed aggregation of sperm cells, surrounded by a non-cellular, strongly eosinophilic area. Unlike the similar "spermatheca" found in *Marsipobdella sacculata* Moore, 1952, there is a broad connection between the lumen of the seminal receptacle and the male bursa.

The female gonopore is inconspicuous in cross-section and difficult to discern externally. The paired ovisacs (Fig. 3, F), which extend from ganglion XII to ganglion XIII, inclusive, contain many immature ova. Although the mid-ventral epidermis in the region of the female gonopore is remarkably thin in the individuals sectioned, no distinct copulatory zone could be distinguished externally. In some of the cross-sections a pair of conducting strands occur on either side of the oviduct from near the female gonopore to the posterior portion of the seminal receptacle. In addition, the cells from the posterior part of the seminal receptacle are continuous with the anterior part of each of the ovisacs. The exact relationship between the seminal receptacle and both the oviduct and ovisacs has not been further determined, but the structures are remarkably similar to those of *Calliobdella lofthii* Van Beneden and Hesse, 1863, and *C. nudulifera* (Malm, 1863) figured by Johansson (1896, Fig. 15), Brumpt (1900, Fig. 8), and Leigh-Sharp (1914, Fig. 3).

A definite basophilic epithelium surrounds the lumen of the vas deferens, the bulbus ejaculatorius, the ductus ejaculatorius, the medial atrium, the bursa and portions of the seminal receptacle. The secretory cells of the atrial cornua and the medial atrium are columnar and have strongly eosinophilic granules, whereas those of the bursa and the seminal receptacle are more irregularly shaped and have basophilic granules. No columnar, granular cells occur in the vas deferens, the ejaculatory bulb or the ejaculatory duct. In the immature specimen (3.0 mm) all parts of the reproductive system are poorly developed and strongly basophilic. A solid aggregation of cells, which may correspond to the seminal receptacle of the adult, extends posteriorly from the bursa to the solid, bilobed ovaries, which terminate at ganglion XII.

In adult *C. carolinensis* large clitellar gland cells with deeply eosinophilic secretory granules occur between the gut and the body wall, primarily in segments XIII through XXII. In the immature specimen the granules of the clitellar glands do not stain with eosin. The secretory ducts from these glands can be traced from

ganglion XVII to the clitellar segments (X through XII) where the ducts (6–10 mm in diameter) project through the body wall. From ganglia XIV through XV these secretory ducts aggregate into three pairs of bundles: a small dorsal, a large dorso-lateral, and a large ventro-lateral bundle. In segment XIII the last bundle divides into two: a ventral pair and a ventro-lateral pair. Secretory cells resembling these clitellar gland cells (probably the pre-clitellar gland cells of other piscicolids) and their ducts occur in segments VIII and IX.

ECOLOGY: *C. carolinensis* is known to occur in South Carolina estuaries from Beaufort to Georgetown. Around Charleston *C. carolinensis* has been found in salinities from 4‰ to 32‰ during the months of January through April. Although often found free-living on *Ulva lactuca* and other chlorophytes, it feeds primarily on two species of clupeid fish, the Atlantic menhaden, *Brevoortia tyrannus*, and the blueback herring, *Alosa aestivalis*. A more detailed account of the biology of the species will be published elsewhere.

DISCUSSION

Based on superficial characters alone, *Calliobdella carolinensis* definitely belongs to the freshwater *Piscicola-Cystobranchius*, and the marine *Calliobdella-Trachelobdella* complexes of genera, all of which (except some *Trachelobdella*) possess six pairs of testisacs, two pairs of eyes on the oral sucker, external pulsatile vesicles, fused posterior crop ceca and an elongated, subcylindrical body, narrower than the caudal sucker. The structure of the male and the female reproductive systems closely resembles the European marine *Calliobdella*, which was reviewed by such early workers as Johansson (1898) and Stshegolew (1912). The unique reproductive structure in this genus was examined in depth by Johansson (1896), Selensky (1915) and Brumpt (1900). In *Calliobdella carolinensis* the weakly muscularized "seminal receptacle" which leads posteriorly from the bursa and is confluent with the conductive tissue of the female system corresponds with a similar but less well developed structure found in both species of *Calliobdella*, *C. lophii* and *C. nodulifera*. Selensky (1915) in referring to this structure writes: "Strands of the conducting tissue come to the posterior wall of the bursa, in the place of their contact with the epithelium arises the copulation area. We will note besides that the pair of longitudinal strands anastomize in two places and discharge into the bursa 'tubes' which were described formerly by Johansson (1896, 1898) as 'vesiculae seminales' are evidently nothing but the mentioned traces of the conducting tissue." The sperm-filled "seminal receptacle" of *C. carolinensis* is slightly paired at its extreme posterior end, which is evidently an elaboration of the paired "vesiculae seminales" noted by Johansson. In addition to differing from its congenitors in the shape and size of the seminal receptacle, *C. carolinensis* differs in the proportions of the body, the oral and caudal suckers, the host upon which they feed and the ecological conditions in which they occur.

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SUMMARY

1. A new species of marine leech is reported from the estuaries of South Carolina on the clupeid fishes, the Atlantic menhaden, *Brevoortia tyrannus* (Latrobe) and the blueback herring, *Alosa aestivalis* (Mitchill).

2. The leech, which is provisionally assigned to the genus *Calliobdella*, has the following characteristics: 14-annulate, two pairs of cephalic ocelli, no ocelli on caudal sucker, 11 pairs of pulsatile vesicles and a well-developed medial, muscular organ which functions as a seminal receptacle.

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